Lessons Learnt

Lessons Learnt Report: *Impact of cell texture on module output*

Project Name: *Photovoltaic Modules for the Australian Environment (PV-MATE)*

Knowledge Category:	Technical
Knowledge Type:	Technology
Technology Type:	Solar PV
State/Territory:	Canberra ACT, Adelaide ACT

Key learning

We find that the angular optical performance of solar cells surrounded by air varies strongly with cell texture, but when embedded in a module structure these variations are mitigated significantly. Therefore the advantages of a high angular absorption of solar cells are not fully transferred to the module level. This is especially notable for plasma etched, black silicon cell structures, which suffer comparatively from poorer index matching and light recycling inside a module structure.

Implications for future projects

This research pointed out that the module embedding need to be optimized for higher angles of incidence. This needs to be done at the air/glass surface. Optimizing cell textures for angles of incidents above 50 degree is not useful.

Knowledge gap

We determined the losses generated by the solar embedding materials under standard test condition and under higher angles of incidence. Based on this we pointed out the impact of cell texture on the annual yield of a module. In previous publication the focus was predominantly on the solar cell properties and it was unknown what would happen within a module compound.

Background

Objectives or project requirements

We wanted to determine how cells in air and after being embedded can absorb of angular incoming light and how much of the annual yield losses is caused by the module embedding material to pint out the impact of module design on yield optimization in opposite to cell optimization.

Process undertaken

We measured the angular spectral reflectance of cell textures in air and after being embedded in a module with and with antireflective coating on the glass surface. Then we calculated the angular effective absorbance of all textures and configurations and based on this we calculated the annual optical yield .

Supporting information

Submitted for SOLMAT (Solar Energy Materials and Solar Cells): I. Haedrich et al. “How cell textures impact angular cell-to-module ratios and the annual yield of crystalline solar modules”, 2018

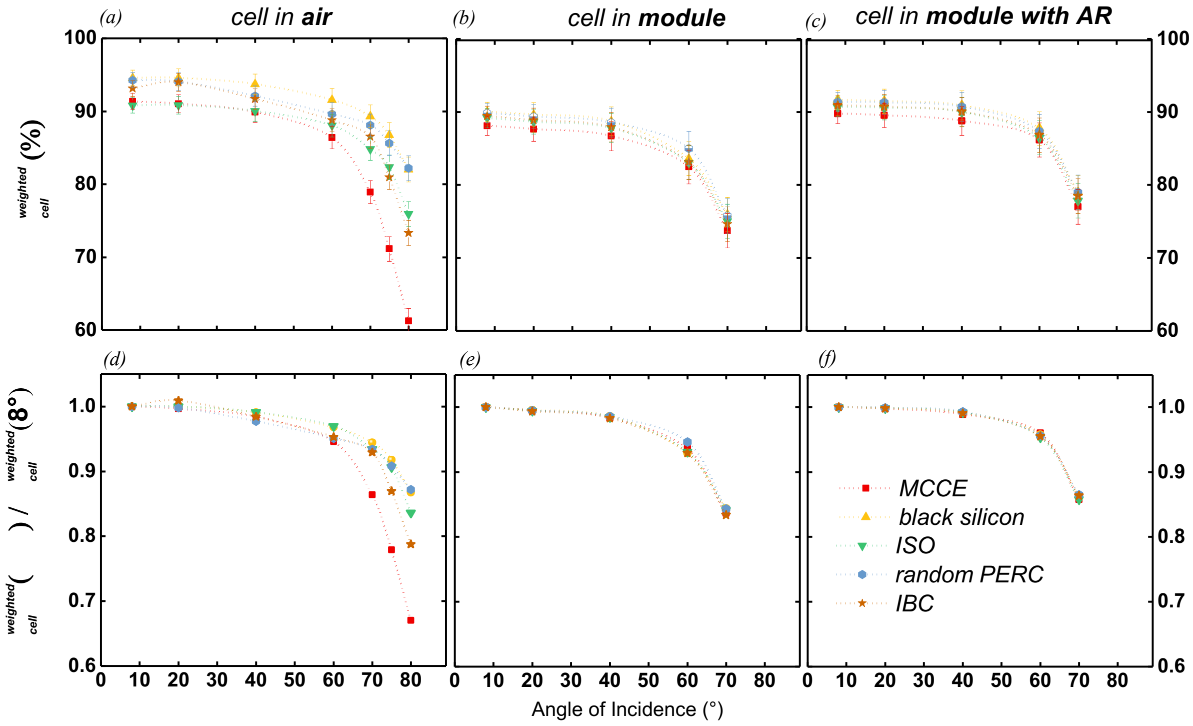

Figure 1: Absolute (a-c) and normalized (d-f) weighted angular absorption curves plotted for 5 of the investigated cell structures (see APPENDIX B for all cell types). The cells show a wide spread when surrounded in air, but when embedded into a module (with or without ARC) the variance in angular absorption is significantly reduced so that all cell structures perform nearly the same. Graph (e) and (f) show nearly no spreading of the data.

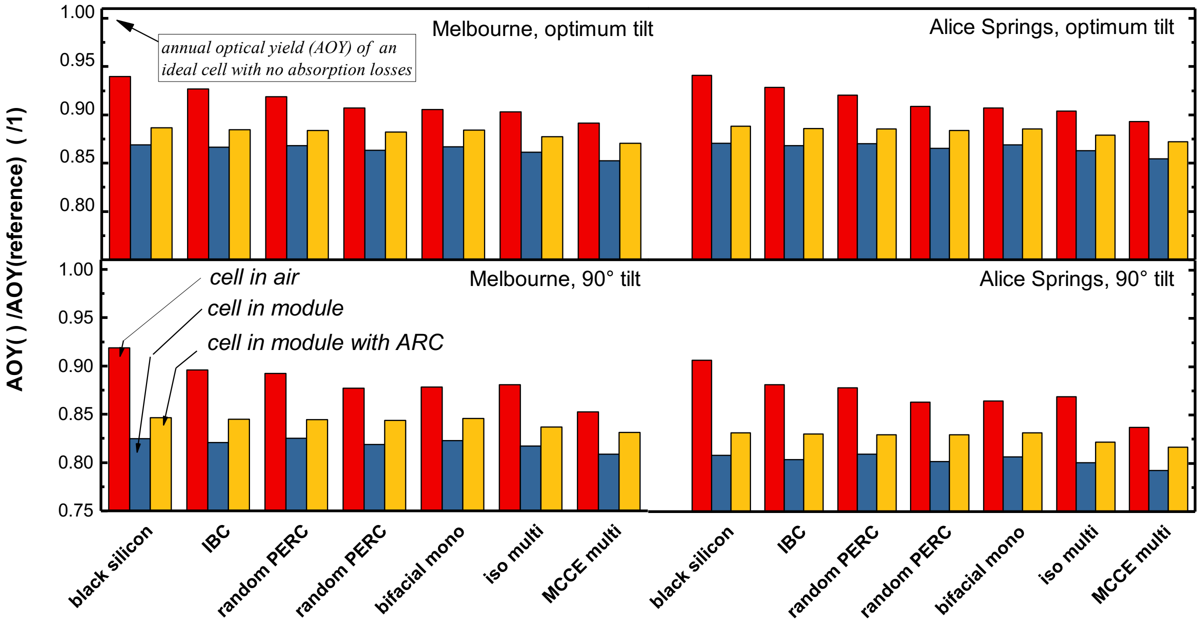

Figure 2: annual optical yield (AOY) normalized to the theoretical yield of an ideal solar cell with a spectral absorption of 1. The yield is calculated for a location with high direct irradiance (Alice Springs) and high diffuse irradiance (Melbourne) for modules installed at optimum tilt and integrated into a façade with a 90° tilt. For all locations and both tilts the black silicon cell structures in air reach a significantly higher annual yield (5 % more than MCCE multi cell). When embedded in a module the cell types show an annual yield which then only spreads by less than 2% between the highest and the lowest.